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Methods of Cultivation and Crop Productivity in Rain-fed Mechanized Schemes in Sennar State, Sudan

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Abstract: The objective of this study was to obtain baseline information about the methods of cultivation and crop productivity in the Rainfed Mechanized Schemes (RMS) in Sennar State. Forty farmers were selected from Eldindir, Singa and Sennar localities. The data collected was in the form of questionnaires, meetings and group discussion with farmers. The questionnaire was designed to obtain information about the area per scheme, areas allocated for cultivation, cultural practices, crops grown, and their yields. SSPS software programme was used for data analysis. The results revealed that the largest scheme areas were at Singa followed by EL Dindir and the smallest areas were at Sennar. Farmers at Sennar allocate all the area for crop cultivation, whereas at EL dindir and Singa, 53.4 and 66.7% of the farmers allocate area for cropping and the rest for forest, respectively. Sorghum and millet are grown in all localaties, while sesame and sunflower are grown only at EL dindir and Singa localities. Land preparation in all locations started by clearance of trees and perennial bunch grasses. Sowing is by wide level disc planter in EL Dindir and Singa, while in Sennar, sowing is by seed broadcast and ridging. In all localities weeding is manually after two or three weeks from sowing and some farmers use herbicides in combination with manual weeding. None of the farmers use fertilizers and pesticides. No proper crop rotation is applied in all localities. All farmers harvest sorghum and millet manually and mechanical threshing, while sesame is harvested manually and sunflower mechanically. The yields of all grown crops are low and not exceeding an average of 414, 252, 207 and 255 kg seeds per feddan for sorghum, millet, sesame and sunflower, respectively.

Key words: Sennar State rain-fed, mechanized farming, mechanized schemes.

INTRODUCTION

Experimental data seek to provide answers to specific agricultural problems and thus may lead to recommendations of relevance. However, agricultural production sometimes is faced with handicaps that not lend themselves to experimentation in the understood sense. Therefore, sound surveying and data collection can be achieved by reallistic observation, questionares and inerviews with representative samples of farmers to study agricultural problems. This sudy is of socio-ecomnomic nature.
Mechanization of rain-fed sorghum was initiated by the British in Gadaref area in 1944 in response to the shortage of sorghum, the staple food grain for most of the Sudanese. The shortage was due to the increase in demand by the British armies during the Second World War in East and North Africa. The main crops grown in this sector are sorghum and sesame. Mechanized farming accounts for about 65% of the sorghum, 53% of the sesame, 5% of the millet, and almost 100% of sunflower produced in Sudan (Mustafa, 2006). Historically, this sub-sector has been a source of sorghum exports as well as meeting internal needs particularly in urban areas (MEPD, 2003).

The Sudanese government expanded mechanized farming after independence in 1956, and encouraged investment in this sector. Now, mechanized agriculture occupies an area of about 6.5 million hectares, extending from the Butana in the east, the central clay plains of Gedarif, Kassala, Blue Nile, Sennar, White Nile, Gazira and Southern Kordofan states. This enterprise includes 10,000 large farmers with holdings of

400-850 ha and a few companies with holdings of 8,400-84,000 ha. The actually cultivated area and yield vary considerably from year to year depending on rainfall fluctuation. Nonethless, this sub-sector has a high potential of building, a national food stock and foreign exchange earnings which could contribute substantially to the development of the whole economy, whenever rains are favourable and input and output prices are state-conrolled. Furthermore, land utilization for the different agricultural outputs requires sound national agrarian polices which are convincing to the producers and the executive local authorities. National polices should

avoid mis-interpretation of facts and conflicting interests. The objective of this study is to obtain baseline information about the methods of cultivation and crop productivity that may be useful for future development in the Rainfed Mechanized Schemes (MS) at Sennar State.

MATERIALS AND METHODS

For the purpose of this survey, forty farmers engaged in the large rainfed mechanized farming at Sennar State were randomly selected from three localities with different farm areas according to the number of farmers in each locality as follows:

1- EL dindir Locality, 15 farmers.
2- Singa Locality, 15 farmers.
3- Sennar locality, 10 farmers.

The survey was conducted in May 2009 with the help of the staff in the Administration of Rain-fed Sector of the Ministry Agriculture in each locality. Data collection was in the form of meetings, group discussion with the farmers in each locality and questionnaires. The questionnaire was designed to obtain information about the following:

1- Farm area
2- Allocation of the scheme area
3- Cultural practices
4- Crops and yield

Data analysis

Data entry and analysis were done using SPSS and SAS programmes. Excel, a spreadsheet programme, was used to make tables of both qualitative and quantitative data.

RESULTS AND DISCUSSION

Farm area

Table 1, shows the average maximum and average minimum area of farms and land demarcation in each locality. The average area was higher

at Singa (6100 feddans) and EL Dindir (5550 feddans) and the lowest one was at Sennar locality (855 feddans). The difference in areas was due to the difference in the land tenure systems in these localaties. In Singa and El Dindir localities large areas are owned by the government, thus it was possible to lease farm areas of 500 feddans or more per farmer, according to his financial situation. All the schemes in EL Dindir Locality are 100% demarcated but in Singa demarcation was 86.7% and at Sennar locality the schemes are un-demarcated (zero). Government lands are continuous stretches and thus allow the farm areas to be a continuous unit, but at Sennar land ownership is fragmented and thus the farm area is scattered in small pockets.

Table 1. Maximum, minimum and average areas (feddans), demarcation of the farms and status of land tenure at Dindir, Singa and Sennar localities**.**

Location	Area of the Farm (Feddan)		Average	Demarcated farm (%)	Status of land tenure (%)	
	Minimum	Maximum			Lease	Rent
Dindir	1000	16000	5550	100	100	Zero
Singa	500	30000	6100	86.7	86.7	13.3
Sennar	345	1750	855	Zero	Zero	100

The results revealed that there are different types of land tenure:

1- Lease, valid for 10 years, in which the farmer pays on establishment 1600 SDG/1000 feddans in demarcated schemes for land survey, and demarcation plus annual rent of 300 SDG /1000 feddans which have to be paid regardless of land cultivation. Moreover, the farmer should follow the state regulations of how to use the land; otherwise the lease will be transferred to another farmer.

2- The annual rent for un-demarcated land (unplanned type of mechanized farming) is SDG 300/1000 feddan. This system is entirely applied to farmers at Sennar locality (100%) as shown in Table 1. The rent is paid

only when the farmer wants to cultivate the land in any particular year, and he has to get credit from the banks. The lease and rent conditions are subjected to change at any time by the State. Therefore, for both, demarcated and undemarcated land, the tenure is uncertain since the government maintains the authrity to uphold the lease. In spite of this risk, farmers under mechanized agriculture are comparatively better than the traditional pastoralists and subsistence cultivators who do not entertain any services or loan facilities. In fact the extensive expansion of mechanized rain-fed agriculture was at the expense of subsistence cultivators and nomadic herders who lost a large share of their traditional grazing areas and migration routes. This unfair treatment was backed by successive laws and decrees of land tenure (Abdelrahman, 2006). These decrees and laws were challenged by the nomadic tribes on the grounds that their tribal rights for grazing on the expropriated lands dates longer before rainfed mechanized farming (Bebawi *et al.,* 1985). This dispute is considered as one of the main reasons for conflicts between farmers and pastoraists for the use of the resources in the area.

Allocation of land on the farm

All the farmers in Sennar allocate the farm area for cultivation, while in EL Dindir and Singa 53.4% and 66.7% of the farmers allocate the farm area for cultivation while the rest is reserved for forest, respectively (Table 2). The absence of forest wthin the farm of Sennar locality is due to the poor tree cover and the preference of the farmers for crops rather than trees. In contrast, at Singa and Eldindir, forests grow naturally and the farmers cut the trees and replace them with new ones or grow crops whenever soil fertility is renewed. The trees are used for different purposes such as wild fruits, honey bees, gum, browsing and shade. Wood is useful for cooking fire, charcoal, bulding and furniture. This form of agroforestry is becoming more rewarding in the short and long run, provided that tree cutting and reforestation is properly manged.

The cultivated crops

According to the survey, the main crops are sorghum (*Sorghum bicolor* L.), pearl millet (*Penniseium glaucum* L.), sesame (*Sesemum indicum* L.) in the three localities. Sunflower (*Helianthus annuus* L.) is grown to some extent , in Singa and EL dindir (Table 3).

Sorghum is the staple food for the sudanese people until 1950, so it was the only crop grown in the mentioned localities. Thereafter, white-seeded sesame was introduced on small areas (Simpson and Simpson, 1978). The area under sorghum is about 87%, and only 12% allocated for sesame and 1% for other crops. The government emphasized the introduction of sesame into the rotation for export diversification and to reduce the dependence on cotton. The suggested rotation was cotton-sorghum-sesame-fallow (Mustafa, 2006). However, sesame is very sensitive to water logging in its early stages when rainfall is excessive, and suffers from water stress when rains are scarce. Consequently, little progress was made with crop diversification, especially in small farms where sorghum or millet are preferred. Sunflower and Guar were grown by companies and by few farmers in Singa and Eldindir localities.

Table 2.The percentage frequency of farmers who allocate all areas for crops and those who allocate paert of the area for forest .

	Allocation of land	
Location	Farmers who allocate all area for cultivation (%)	Farmer who allocate part of the area for forest area (%)
EL Dindir locality	53.4	46.7
Singa Locality	66.67	33.3
Sennar Locality	100	Zero

Table 3. Cultivated crops in different localities of Sennar State

Locality	Cultivated crops			
	Sorghum	Millet	Sesame	Sun flower
EL Dindir	+	+	+	+
Singa	+	+	+	+
Sennar	+	+	+	−

+ = Cultivated
− = Not cultivated

Cultural practices:

The cultural practices adopted to produce the different crops in the different localities are summarized in Table 4. Land clearance is practiced at El Dindir and Singa due to higher vegetation cover compared to that at Sennar. In all localities, no deep plouging is practiced and this is considered as one of the main factors that lead to low crop productivity in all mechanized schemes. This benfit was shown by one of the farmers in EL dindir. He obtained from that part three times the yield obtained from the un-ploughed one. The farmers know the importance of this practice, but they cannot afford the high cost of deep ploughing.

No fertilizers or pesticides are used, although fertilization is recommended under rain-fed conditions, whether mechanized or traditional (Faisal, 1974; Ageeb, 1974; Ahmed, 1994; Dawelbeit, 2010). Only big companies could afford their cost and realize the risk of lack of response to fertilizes in the event of poor rainfall. Pesticides are used only for the so called national pests such as desert locusts, rats, Dura Andat and birds under the Administration of Crop Protection in each locality.

About 80%, and 20% of the interviewee in EL Dindir and Singa, respectively, rotate crops with fallow. Dura and millet are grown after sesame or sunflower, followed by a fallow. No rotation with fallow is applied at Sennar where sorghum is cropped continuously with small areas of millet. To ensure sustained crop productivity, the government recommended half of the area to be allocated for crops and half is to be left as fallow. After four years, the originally leased land is to be returned to fallow and the farmer has to receive a new lease to an adjacent fallow area. This system did not persist very long because the demand for the land by the investors grew faster than the ability of the authority to demarcate the land. So, more land became under cultivation. The farmers usually allocate larger areas for sorghum and relatively small areas for other crops such as sesame and sunflower, with limited rotation fo the other crops. In the Sudanese - Canadian Mecahized Scheme, it was found that growing sorghum after other crops (sesame, sunflower,cotton) and fallow resulted in 24 to 36% increase in yield compared to sorghum after sorghum (Amin, 1990). Moreover, Agricultural Research

Corporation (ARC) strongly recommended the application of crop rotation and fallow in both the traditional and mechanized rain-fed farming systems (Omer *et al*, 1990; Ahmed, 1994) but the farmers in most cases ignore this fact.

All the interviewed farmers harvest sorghum by cutting manually and mechanical threshing except at EL Dindir where one farmer who owned a combined harvester for his own farm (Table 5). With this exception, threshers, are either owned or rented. All farmers who cultivate sunflower use the combined harvester on rent basis for the small areas allocated for this crop. Sesame is harvested manually in traditional and in large scale farms in the absence of of proper sesame harvesters in Sudan.

Crop Yield

Table 6 shows that the yield of sorghum was similar in all localities and the highest yield for pearl millet was at Sennar locality (405 kg per feddan). Sesame, which is grown mainly in EL Dindir and Singa, recorded the highest yield at 236 kg/fed at Eldindir. Sunflower yield was higher in the Singa Locality than at EL Dindir. Comparing all crops, sorghum scored the highest yields. This might be due to the fact that sorghum is the most adapted traditional crop in the area and the farmers knew traditionally the crop management. In addition to the sensitivity of sesame to extreme moisture conditions, and the problem of shattering at time of harvest. Sunflower is a new crop in the area and farmers are not yet acquainted with its cultivation. Generally the yields of all cultivated crops are lower compared to the similar tropiacl parts of the world, probably due to the following factors:

(1) Erratic rainfall and decline in soil fertility. With declining soil fertility and an erratic and variable rainfall, there has been an increasing variability in output over time (Salih, 1993).

(2) Absence of rotations and continuous cultivation of sorghum in the absence of chemical fertilizers.

(3) The improper land preparation by using the wide-level disc. This implement is manufactured mainly as a planter to do light tillage operation, but the farmers use it for other purposes beside sowing, such as secondary tillage and pre-sowing weeding. The use of this implement year after year, resulted in soil compaction that lowers the capacity of the soil to conserve moisture for crop growth.

(4) Lack of pest and disease control other than the national campaigns for certain pests such as rats and desert locust.

(5) Weed infestation, such as Buda (*Striga hermothica*) and pests (Bebawi *et al*., 1985)

The main conclusion that can be drawn from this study is that inadequate cultural practices such as poor improper land preparation, negligence of crop rotation and absence of chemical fertilizers are the reason for low production potential in rainfed agricultural schemes

Table 4. The percentage frequency of farmers who performed different cultural practices in different localities.

Locality	Land preparation and sowing (%)				Weeding (%)		Use of chemical fertilizers and pest control (%)	
	Clearance of trees	Discing	Deep Ploughing	Ridging	Manual	Manual + herbicides	Fertilizers	Pesticides
EL Dindir	93.3	100	0.0	0	6.67	93.3	0	0
Singa	73.3	100	0	0	20	80	0	0
Sennar	40	20	0	80	90	10	0	0

Table 5. Harvesting methods used by farmers in different localities at Sennar State

localaties	Harvesting methods								
	Sorghum			Sesame			Sunflower		
	FUFM (%)	FUMCT (%)	FUCH (%)	FUFM (%)	FUMCT (%)	FUCH (%)	FUFM (%)	FUMCT (%)	FUCH (%)
EL Dindir	0	93.3	6.7	100	0	0	0	93.7	6.7
Singa	0	100	0	100	0	0	0	86.7	13.3
Sennar	0	100	0	100	0	0	0	0	0

FUFM (%) : Farmers using Full manual (%)
FUMCT (%) : Farmers using Manual cutting and mechanical threshing (%)
FUCH (%) : Farmers using Combined Harvester (%)

Table (6). Crop yields (kg/feddan) in different localities

Location	Sorghum	Millet	Sesame	Sunflower
EL Dindir	411	281	236	207
Singa	392	262	186	285
Sennar	450	405	-	-

RECOMMENDATIONS

1- Reduction of input costs should be a national policy.
2- New technology in machinery for all operations (full mechanization) to reduce labour cost and exact time of operation.
3- Use of herbicides.
4- Improved seed genotypes.
5- Support from the government to agriculture through efficient credit system with long term loans to help cover the production costs.
6- Guaranteed prices for crops as a government policy.
7- Improvement in use of rain water by suitable water harvesting techniques, to be adopted on small and large scale techniques using investors contribution where possible and mainly as a national responsibility.
8- Extensive extension services to apply the proper cultural practices by demonstration fields and by collaboration with progressive farmers in the different localities.

REFERENCES

Abdelrahman, M.E. (2006). Land use and misuse Problems in Sudan. Ministry of Agriculture. Natural Resource Administration Report, Khartoum, Sudan.

Ahmed. M.A.M, (1994). Introducing New Technologies on the Vertisols of Eastern Sudan: A Dynamic Programming Approach. *Ph.D Thesis, Purdue University*, USA.

Amin, A. 1(990). The Sudanese-Canadian Scheme in the Rainfed Agriculture. Conference of Rainfed Mechanized Agriculture: Production Issues in the Rainfed Mechanized Sector. May 12 -15, Gadaref, Sudan. (in Arabic)

Ageeb , O.A. (1974) .Response of three sorghum varieties to N-fertilization at Agadi State Farm . 11th Research colloquium_on . Cereal Crops in the Sudan

Bebawi, F.F., EL hag, G.A. and Khogali, M.M. (1985). The production of Dura (*Sorghum vulgare*) in Sudan and parasite Buda (*Striga hermonthica*). In: Natural Resources Development in Arid Lands; Case Study from Sudan. Ed. H.R.J. Davies. The United Nation University.

Dawelbeit, S.E,F.M. Salih F.M,. Dahab, ,O.A and Ahmed, E.H. (2010). Status of Fertilization and Crop Nutrition in Irrigated Agriculture in Sudan 1: Fertilizer Use in Sudan. International Reseach Institute, Research Findings: *e-ifc* No. 23, June 2010

Faisal M.Ali. (1974). Rotation responses of sorghum at Kenana Research Station 11th Research Colloquium on Cereal Crops in the Sudan.

MEPD. (2003). Ministry of Environment and Physical Development. Sudan's First National Communications under the United Nations Framework Convention on Climate Change. Volume 1.

Mustafa, R.H. 2006. Risk Management in the Rain-fed Sector of Sudan: Case Study, Gedaref Area Eastern Sudan. Ph.D thesis, Justus – Liebig University, Giessen, Germay.

Omer, A.B., Ibrahim, O.E., Farah, S.M. and Babikir, I.A. (1990). The role of Agricultural Rsearch Corporation in Development of Rainfed Mechanized Agriculture. Conference of Rainfed Mechanized Agriculture: Production Issues in the Rainfed Mechanized Sector. May 12 -15, Gadaref, Sudan (in Arabic)

Salih, A.A. (1993). Sustainability and Profitability of Intensive Cropping Technologies on the Dryland Vertisols of the Sudan: A simulation approach with EPIC. Unpublished Ph.D thesis, Purdue University, USA.

Simpson, I.G. and Simpson, M.C. (1978). Alternative Strategies for Agriculture in the Central Rain lands of the Sudan, Rural Development Study, No. 3. University of Leeds.

طرق فلاحة وإنتاجية المحاصيل فى مشاريع الزراعة الآلية بولاية سنار، السودان

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المستخلص: هدفت هذه الدراسة للحصول على معلومات أساسية عن طرق فلاحة المحاصيل وانتاجيتها بمشاريع الزراعة الآلية المروية بالأمطار بولاية سنار. أختير 40 مزارع من محليات الدندر، سنجة و سنار. كانت البيانات التى جمعت فى شكل استبيانات و مجموعات نقاش مع المزارعين. صمم إستبيان للحصول على معلومات عن مساحات المشاريع و المساحات المخصصة لزراعة المحاصيل والعمليات الفلاحية والمحاصيل المزروعة وانتاجيتها. حللت المعلومات باستخدم برنامج SPSS الإحصائى. أظهرت النتائج إن اكبر مساحة للمشاريع توجد فى سنجة و تليها الدندر، بينما اصغر مساحة توجد فى سنار. خصص المزارعون فى سنار كل المساحة لزراعة المحاصيل، بينما فى الدنر وسنجة فإن 53.4% و 66.7% من المزارعين يخصصون المساحة لزراعة المحاصيل وباقى المساحة لأشجار الغابات، على التوالى. يزرع محصولا الذرة والدخن فى كل المحليات بينما يزرع محصولا السمسم و زهرة الشمس فى سنار وسنجة. يبدأ تحضير الأرض فى كل المحليات بنظافة الأرض من الأشجار و الحشائش المعمرة المخصلة. تتم الزراعة باستخدام الزرّاعات ذات القرص العريض فى الدندر و سنجة، بينما فى سنار تتم الزراعة بنثر البذور و استخدام الطراد. فى كل المحليات تزال الحشائش يدويا بعد اسبوعين أو ثلاث اسابيع من الزراعة و يستخدم بعض المزارعين مبيدات الحشائش مع الإزالة اليدوية. لا يستخدم المزارعون الأسمدة ومبيدات الآفات. لا تطبق الدورة الزراعة بالطريقة المثلى فى كل المحليات. تحصد الذرة والدخن بالقطع اليدوى و الدرس الآلى، بينما يحصد السمسم يدويا وزهرة الشمس بالميكنة. إنتاجية كل المحاصيل المزروعة متدنية و لا يزيد متوسط الأنتاج من 414 و 252 و207 و 225 كجم من الحبوب للفدان من الذرة والدخن والسمسم وزهرة الشمس على التوالى.